In the Claims

This listing of claims, as required by 37 C.F.R. §1.121(c), replaces all prior versions of claims in the application. Claims 3-6, 8-9, 11-12 and 15 have been amended. Deletions therefrom are indicated by strikethrough text and additions thereto are indicated by underlining. A clean version of the claims is attached hereto as Appendix A ("Clean Version of Claims").

CLAIMS

1. (original) A method for automatically detecting and tracking the contour of a starting image, said starting image being formed by an array of pixels and each pixel having an intensity, being *n* and *m* coordinates of a generic pixel, comprising the steps of:

– filtering said starting image through an absolute central moment $e(n,m)$ of the intensity of the pixels of said starting image, wherein said absolute central moment is obtained with the following steps:

  – determining for each n,m a local mean calculated on a neighborhood about a pixel of coordinates n,m of the starting image, obtaining a first filtered image;

  – determining for each n,m a sum of absolute differences between the intensity of the pixel having coordinates n,m of the first filtered image and the intensity of all the pixels contained in a neighborhood about said pixel of coordinates n,m of either said starting image or a second filtered image derived from said starting image,

  – wherein said sum of absolute differences is split calculating a sum of positive differences, or positive deviation, and a sum of negative differences, or negative deviation.

2. (original) Method according to claim 1, wherein said sum of absolute differences is calculated computing the differences between said first filtered image and said second filtered image, wherein said second filtered image is obtained for each n,m from a local mean calculated on a neighborhood about the pixel of coordinates n,m of said starting image.

3. (currently amended) Method according to claim 1, wherein said absolute central moment $e(n,m)$ is calculated in a generalized way as follows:

$$e(n,m) = w_4(n,m) \otimes \sum_{(k,l)\in\Theta_3} \sum |\mu_1(n,m) - \mu_2(n-k,m-l)| w_3(k,l) \quad (1)$$

where:

n,m are the coordinates of a pixel of a map $f(n,m)$ of said image;

$w_1(n,m)$, $w_2(n,m)$, $w_3(n,m)$ and $w_4(n,m)$ are four weight functions defined on four circular domains Θ_1, Θ_2, Θ_3 and Θ_4, <u>each point of said domains</u>

having coordinates *(k,l)*, said circular domains Θ_1, Θ_2, Θ_3 and Θ_4 having respectively ~~of~~ radius r_1, r_2, r_3 and r_4 and being defined as $\Theta_i = \{(k,l) \in I^2 : \sqrt{k^2 + l^2} \le r_i\}$;

$\otimes$ is a convolution operator;

$\mu_1(n,m) = \sum\sum_{(k,l)\in\Theta_1} f(n,m)w_1(n,m)$ is a mean value on domain Θ_1 of said map and of said first filtered image;

$\mu_2(n,m) = \sum\sum_{(k,l)\in\Theta_2} f(n-k,m-l)w_2(k,l)$ the mean value on domain Θ_2 of said map and of said second filtered image.

4. (currently amended) Method according to ~~claims~~ claim ~~3 and~~ 4, wherein, starting from said absolute ~~generalized~~ central moment *e(n,m)* calculated in said generalized way, said positive deviation $e_p(n,m)$ and said negative deviation $e_n(n,m)$ are used as further filters, defined as

$$e_p(n,m) = w_4(n,m) \otimes \sum\sum_{(k,l)\in\Theta_{3p}} \left(\mu_1(n,m) - \mu_2(n-k,m-l)\right) w_3(k,l)$$

$$e_n(n,m) = w_4(n,m) \otimes \sum\sum_{(k,l)\in\Theta_{3n}} \left(\mu_1(n,m) - \mu_2(n-k,m-l)\right) w_3(k,l) \qquad (7)$$

where domains Θ_{3p} and Θ_{3n} are defined as:

$$\Theta_{3p} = \{(k,l) \in \Theta_3 : \mu_1(n,m) > \mu_2(n-k,m-l)\}$$

$$\Theta_{3n} = \{(k,l) \in \Theta_3 : \mu_1(n,m) < \mu_2(n-k,m-l)\} \qquad (8)$$

5. (currently amended) Method according to claim 4, wherein said step of computing the absolute ~~generalized~~ central moment of the intensity of a pixel comprises the steps of:

– defining said circular domains Θ_1, Θ_2, Θ_3 and Θ_4, in a neighborhood about each point of the starting image, wherein Θ_1, Θ_3 and Θ_4 are centered on *n,m* and Θ_2 is a domain centered respectively on each point inside Θ_3;

– associating to each domain Θ_i, with *i* comprised between 1 and 4, a weight function w_i and computing a mean value μ_i of a grey levels map for domains Θ_1 and Θ_2 on the basis of said w_i;

– computing the absolute ~~generalized~~ central moment $e(n,m)$ on the basis of a weight function w_3 on domain Θ_3;

– splitting the absolute ~~generalized~~ central moment $e(n,m)$ into a positive deviation $e_p(n,m)$ and a negative deviation $e_n(n,m)$, thus creating ~~at said~~ near a discontinuity two partially overlapping bell-shaped profiles;

– convoluting ~~the two~~ said positive deviation $e_p(n,m)$ and said negative deviation $e_n(n,m)$ ~~deviations~~ with weight function w_4 on domain Θ_4;

– measuring said discontinuity using said positive deviation $e_p(n,m)$ and negative deviation $e_n(n,m)$ as filters.

6. (currently amended) Method according to claim ~~6~~ 5, wherein said step of measuring discontinuity is carried out by tracking of a function

$Min(e_p(n,m),|e_n(n,m)|)$

7. (original) Method according to claim 6, wherein said step of measuring discontinuity is carried out through a subtraction defined as:

$$e(n,m) = e_p(n,m) - e_n(n,m)$$

8. (currently amended) Method according to claim 6, wherein a DoG filter (difference of Gaussian curves) is obtained using a sum of said positive $e_p(n,m)$ and negative $e_n(n,m)$ deviations of the ~~central~~ absolute central moment $e(n,m)$.

9. (currently amended) Method according to claim 1, wherein said starting images are selected from the group of biomedical imaging techniques consisting of:

– ~~biomedical images, obtained with~~ ultrasonic pulses, PET, SPECT, CAT, MR, ~~etc,~~ among which anatomical images, or images of function, obtained by means of time sequences of anatomical views of a particular zone of an organ, or perfusion images, obtained on the same organ after treatment of the patient with substances that enhance the perfusion in the organ; images of graphs acquired by a scanner in order to convert paper graphs into digital signals.

10. (original) Method according to claim 9 wherein, in case of images of graphs, scanned images are filtered with said absolute central moment *e(n,m)* tracking it as a bell-shaped profile whose peak is the sought digital signal, a further step being provided of computing the digital signal with a local maxima detection algorithm of standard type.

11. (currently amended) Method for contour tracking, according to claim 3, characterized in that at a discontinuity said ~~generalized~~ absolute central moment *e(n,m)*~~,~~ calculated in said generalized way as

$$e'(n,m) = \sum_{(k,l)\in\Theta_3}\sum |\mu_1(n,m) - f(n-k,m-l)| w_3(k,l) \qquad (12)$$

is compared with a threshold value derived from said generalized absolute central moment, calculated as

$$e''(n,m) = w_4(n,m) \otimes \sum_{(k,l)\in\Theta_3}\sum |f(n,m) - f(n-k,m-l)| w_3(k,l) \qquad (13)$$

12. (currently amended) Apparatus for contour tracking in video images arranged as succession of photograms, ~~characterized in that~~ comprising:

- an arithmetic logic unit,
- ~~is used and~~ one or ~~more~~ several filters ~~are used~~ that calculate a positive deviation $e_p(n,m)$ and a negative deviation $e_n(n,m)$ of an absolute generalized central moment *e(n,m)*~~as defined in claim 1~~
- a calculating means residing in said arithmetic unit for obtaining said absolute generalized central moment *e(n,m)*, wherein said calculating means:
  - determines for each *n,m* a local mean calculated on a neighborhood about a pixel of coordinates *n,m* of the starting image, obtaining a first filtered image;
  - determines for each *n,m* a sum of absolute differences between the intensity of the pixel having coordinates *n,m* of the first filtered image and the intensity of all the pixels contained in a neighborhood about said pixel of coordinates *n,m* of either said starting image or a second filtered image derived from said starting image,
  - splits said sum of absolute differences calculating a sum of positive differences, or positive deviation, and a sum of negative differences, or

negative deviation.

13. (original) Apparatus according to claim 12, wherein said positive deviation $e_p(n,m)$ and said negative deviation $e_n(n,m)$ are defined as:

$$e_p(n,m) = w_4(n,m) \otimes \sum_{(k,l)\in\Theta_{3p}}\sum (\mu_1(n,m) - \mu_2(n-k,m-l))w_3(k,l)$$

$$e_n(n,m) = w_4(n,m) \otimes \sum_{(k,l)\in\Theta_{3n}}\sum (\mu_1(n,m) - \mu_2(n-k,m-l))w_3(k,l) \qquad (7)$$

where domains Θ_{3p} and Θ_{3n} are defined as:

$$\Theta_{3p} = \{(k,l) \in \Theta_3 : \mu_1(n,m) > \mu_2(n-k,m-l)\}$$

$$\Theta_{3n} = \{(k,l) \in \Theta_3 : \mu_1(n,m) < \mu_2(n-k,m-l)\} \qquad (8)$$

14. (original) Apparatus according to claim 12 wherein said filters consist of four bidimensional convolutors and an integrator.

15. (currently amended) Apparatus, according to claim ~~13~~14, wherein each of said bidimensional convolutors is replaced by a cascade of two monodimensional convolutors.